Space Weather Technical Forecast

Issued on Sunday, 26 March 2023 at 12:03 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1 Minor radio blackouts. Active electron fluence Likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional minor C-class flares recorded at GOES16. These flares peaked with a C2.6 at 26/0406UTC, with this appearing to emanate from the largest and most complex group on the Sun, AR3256. This group showed a slight decrease in area over the 24 hours, with its previous Mt Wilson delta spot(s) fading. Activity around the time of this peak flare was part of a general brightening in near X-ray wavelengths around the southwestern sunspot groups AR3257, AR3259 and AR3256. There are now eight numbered sunspot regions on the visible disc including the above, and perhaps a ninth unnumbered region developing in the form of a small and diffuse unipolar group in the northeast. The only noteworthy growth trend in any spot group of the period was in AR3258 in the northwest, with some trailer development to become a Dao/Beta, although this was with no accompanying flare activity.

Perhaps the most notable event on coronagraphs of the 24 hours was an eruptive flare from AR3262 in the southeastern quadrant around 26/0500UTC. This event has translated into ejecta seen heading largely south and east on coronagraphs and will shortly be analysed. With the possible marginal exception of this CME pending analysis, and despite some fading and disappearing filaments as well as prominence eruptions in the period, at the time of writing no Earth-directed CMEs were observed in available coronagraph imagery.

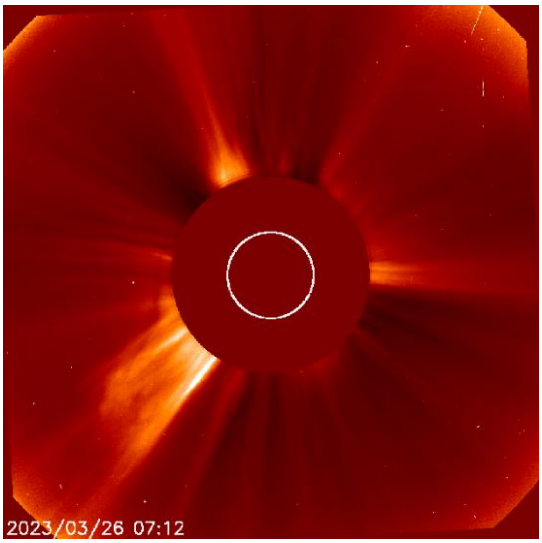

Figure 0: Lasco C2 coronagraph image showing the one unassessed candidate for a CME heading apparently largely south and east of the Sun-Earth line. This will shortly be analysed, however Earth-based impacts appear unlikely.

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Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by DSCOVR, showed Earth as transiting a negative polarity fast wind regime from CH86/-, with the phi angle accordingly negative (towards the Sun) throughout. The solar wind speed rose slightly in the period through Elevated levels: starting near 500km/s and finishing near 575. The solar wind density was roughly level, with a slight rise and fall between 10 and 15ppcc observed. The IMF was at or below 8nT over the 24 hours, with the north-south component variable in character and with a +/-5nT range.

The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic activity, with a provisional peak of '3o' in the 18-21UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels.

The high energy electron flux (greater than 2MeV) measured at GOES16 has increased to Moderate flux in the past 24 hours, with a peak of 663pfu observed at 25/1355UTC. The associated 24-hour fluence remained below the Active (1e8 integrated pfu) threshold, although now with a rising trend. At 26/0001UTC the observed fluence was 2.25e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is most likely to remain Low, but with a Chance of becoming Moderate with any isolated M-class flares. The main region likely to give such flares is AR3256 in the southwest.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs feature in the forecast. Earth is currently within a fast wind from CH86/-. Wind speeds are likely to remain Elevated through the remainder of day 1 (Sunday 26 March) before beginning to slowly ease thereafter.

Geomagnetic activity should peak early in the forecast period with Unsettled (Kp3) intervals and a Chance of Active (Kp4), before becoming largely Quiet once again from day 2 (Monday 27 March) as the fast wind wanes.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to remain at Background levels, but with a Slight Chance of reaching S1 or greater, should any significant flares occur.

The high energy (greater than 2 MeV) electron flux is currently showing a degree of recovery and is likely to rise further, probably breaching the 1000pfu High threshold at diurnal maximum each day through the period. The associated 24-hour fluence is expected is also expected to rise, with Active (1e8 integrated pfu) conditions becoming Likely from day 2 (Monday 27 March).

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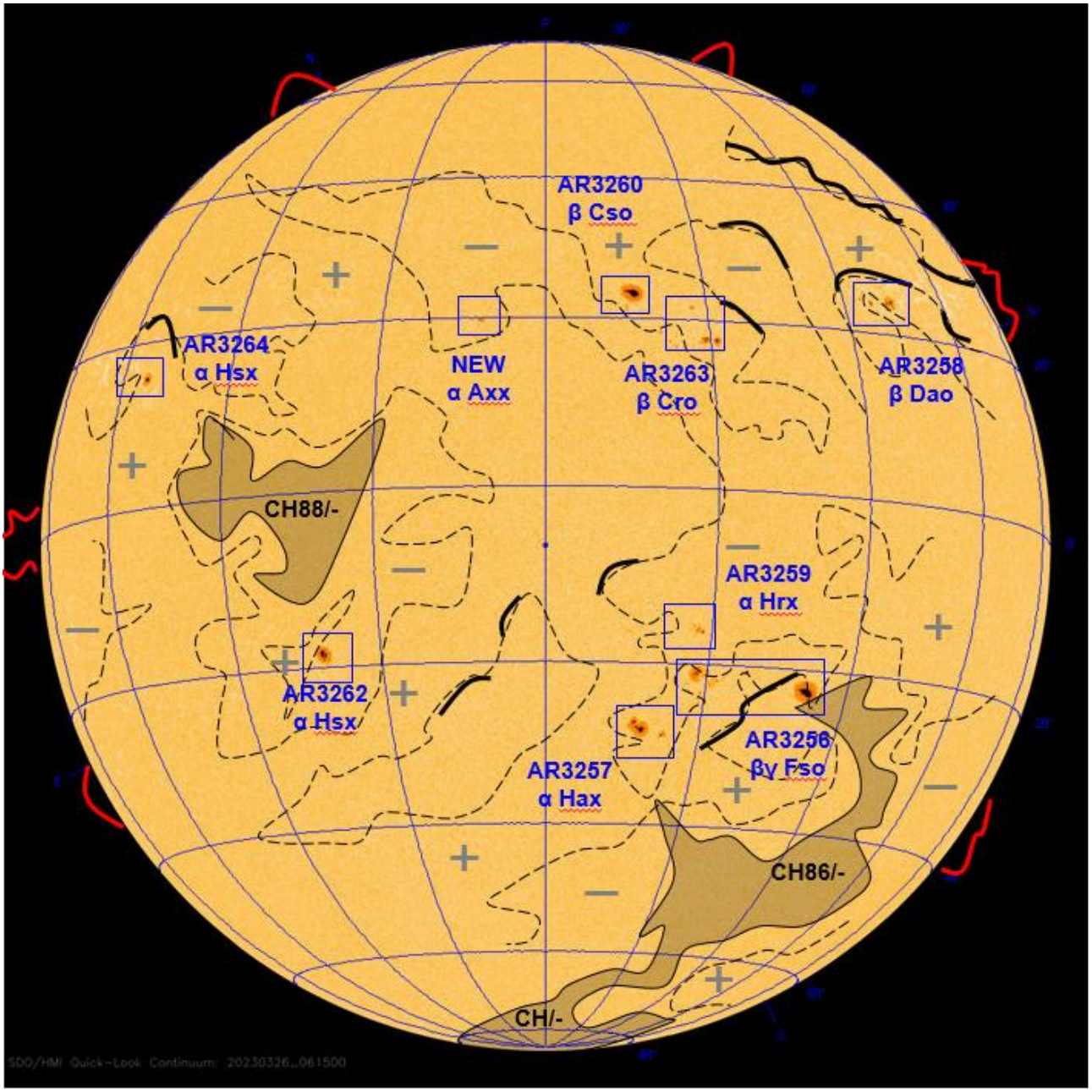
Figure 1. Solar Analysis Valid 26/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in the forecast.

The four-day forecast therefore solely comprises the current fast wind enhancement from CH86/- which is already connected to Earth.

CH86/- is both changed relative to last pass, but also relative to the past few days, with its northern promontory having closed up somewhat, else being largely masked in EUV by flux emanating from AR3256 to its immediate east. Added to this is the fact that STEREO A MAG and PLASTIC measurements to provide a day's forecast upwind are currently very erratic and sparse, and also the fact that the past rotation was heavily polluted by a CME arrival, all add up to a relatively low confidence forecast. In addition, MOSWOC Enlil has only a very tenuous grasp of solar wind conditions at present.

Having said all the above, the coronal hole continues to show its character at L1, and the solar wind speed now appears to be plateauing within Elevated levels. The solar wind is perhaps likely to remain near this level through the remainder of day 1 (Sunday 26 March) before waning from day 2 (Monday 27 March).

The chances of significant geomagnetic activity are now much-reduced relative to the recent past, with Unsettled periods possible and a Chance of Active, waning in earnest to Quiet conditions into the new working week.

The next fast wind feature of note is hinted at in MOSWOC Enlil as a CIR arriving on 30 March, i.e. day 5.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections
Nil.

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Radio Blackouts - X-Ray Flares:

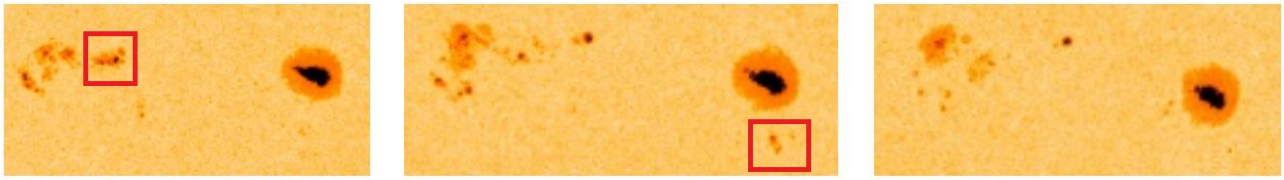
There are currently eight numbered sunspot regions on the visible disc, and perhaps now a ninth as a developing unipolar group in the northeast. While only one of these sunspots is nominally large and magnetically complex, thus far the effect on X-ray activity has been muted for all sunspot regions.

Relative to the raw whole-disc probability of near 60% daily chance of M-class flares, a heavy degree of moderation has taken place, with C-class flares currently barely registering at GOES16. It remains the case that it would not take much development in order for flare activity to increase, however, and for this reason a Chance of M-class is maintained throughout.

Regarding the balance of front-side groups, none leave in the four days, while the Carrington locations for up to four regions are due. These do not yet feature in the forecast, with assessment as to any increase in risk they may deliver pending their arrival over the eastern limb.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X	No	1	1	1	1

Figure 2: 48-hour evolution of AR3256 in HMIIF imagery, showing the development and fading of weak Mt Wilson delta spots (boxed red).



AR3256 HMIIF 24/1145UTC 25/1145UTC 26/1145UTC

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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16 is currently at Background levels.

Proton flux is most likely to remain at Background levels, but with a Slight Chance of reaching S1 or greater should any larger flares occur. The current disc is perhaps under-performing relative to its potential in terms of flares, however the threat remains. Should the current cohort of sunspots begin to flare appropriately, the risk of S1 events may be adjusted upwards over the four days to account for their westward progress, with the rising risk otherwise too slight to show.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux is showing a degree of recovery and is now peaking at Moderate levels. There is considered a reasonably strong potential for further day-on-day increases in flux at first during the four-day forecast period, with the 1000pfu High threshold now considered Likely to be breached at diurnal maximum each day in the expected absence of further significant geomagnetic activity.

Active 24-hour integrated electron fluence perhaps carries a Chance of being realised on day 1 (Sunday 26 March). Given current observed values are significantly above forecast values there is a likelihood that Active fluence levels will be reached from late day 1 or day 2 (Monday 27 March).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	50	60	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 3: Past three days in GOES16 high energy electron flux (top), showing a gradual recovery in levels at GEO in the wake of last week's geomagnetic storms. Also shown (below) is the same period in 24-hour fleunce and the three-day forecast from MOSWOC REFM. The rising trend is accepted, albeit with low confidence, and this may be more accentuated than shown.

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